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AGRICULTURAL MEMORANDUM NO 883

Frequency of Radiation and Wind Frosts during Spring in S E England by C P Roe

The distinction between a radiation frost and a wind frost is well known to most fruit growers. It is possible to provide some protection against radiation frosts but not against wind frosts, apart from the use of shelter to reduce convective heat loss from buds or blossom.

A large capital outlay may be necessary to provide protection against frost and frost data obtained from climatological information can play a major role in the planning of an enterprise where high yielding, but frost sensitive, crops are at risk. This memorandum attempts to determine the proportion of wind frosts for three sites in the SE, namely Gatwick, Manston and Abingdon (replaced by Benson during October 1974).

A study by Hogg (1950) on the frequency of radiation and wind frosts during spring in Kent revealed that between 11 and 60% of all frosts during April (0-43% during May) were wind frosts, depending on site and proximity to the coast. Table 1 shows the mean frost frequency during April and May for three sites in the SE (temperatures $\leq 0^{\circ}C$ are considered).

TABLE 1

Mean Frost Frequency during April and May (Hogg 1950)

Station	Type of Frost	April	May
		Days	
Manston	Radiation	0.8	0.3
	Wind	0.5	0.1
	Total	1.3	0.4
	Wind/Total(%)	37	33
Goudhurst	Radiation	3.4	2.0
	Wind	1.4	0.7
	Total	4.9	2.7
	Wind/Total (%)	29	26
East Malling	Radiation	2.9	1.5
	Wind	1.1	0.5
	Total	4.0	2.0
	Wind/Total(%)	28	23

Hogg's figures were based on observations of wind speed and minimum temperature taken at 0700 or 0900 GMT and adjustments were made for:

a. the increase in wind speed from the probable time of minimum temperature to the 0700 or 0900 observation, which would tend to over-estimate the frequency of wind frost and underestimate the frequency of radiation frost.

b. the apparent difference in the frequency of frost days with different times of observation. Observations made at 0700 are more likely to give rise to two frost days than observations made at 0900.

c. the observed frequencies were adjusted for the diurnal variation of wind speed by factors based on mean hourly temperatures and wind speeds at Kew Observatory.

Methodology

It was suggested by Hogg that wind frosts were associated with wind speeds greater than 4 knots, while Cochrane (1969) quoted a figure of 5 knots. For this (Roe) analysis, a 10 m wind speed of 7 knots (approximately 5 knots near to the surface) has been taken to constitute a wind frost, when combined with the following conditions:

i. a daily minimum screen temperature $\leq 0^{\circ}C$.

ii. cloud cover > 4 oktas

iii. wind direction in the sector NW thro' N to E

iv. small differences between the screen and grass minimum.

Frosts were denoted wind or radiation according to the synoptic situation at 00Z and 06Z. The criteria are not hard and fast rules but merely used as a guide, final decisions being made subjectively on the few ambiguous instances (using reference to D W R charts where necessary).

Data for Gatwick (1959-78), Manston (1961-78) and Abingdon (1959-78) were used for the period 1 April to 2 June. Of the three stations studied, Gatwick is by far the most frost prone, situated in a frost hollow within the valley of the River Mole. One would expect therefore that Gatwick would be more prone to radiation frosts than the other two sites. Manston, however, is very exposed and its coastal location will lower the incidence of radiation frosts. Abingdon and Benson lie on a relatively flat plain, enclosed by the Berkshire Downs to the south and the Chilterns (running SW to NE) to the east.

The average number of days with air frost and the mean daily minimum temperatures (°C), plus extremes, are shown in Table 2.*

TABLE 2

AVERAGE DAILY MINIMUM, EXTREME MINIMUM AND DAYS WITH AIR FROST

Station	Height (m)	Type	MONTH Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Gatwick	59	Daily Min	0.7	0.8	1.2	3.5	6.2	9.0	10.7	10.5	8.9	6.6	3.2	0.6
		Extreme Min	-16.7	-13.2	-11.3	-5.7	-4.0	-1.6	2.8	2.0	-0.7	-3.9	-8.6	-11.0
		Air Frost	13.9	13.7	10.7	6.0	0.7				0.1	2.5	8.4	12.6
Manston	44	Daily Min	1.7	1.8	2.8	5.1	7.8	10.7	12.9	12.9	11.5	8.7	5.2	3.0
		Extreme Min	- 9.4	-11.6	- 6.0	-3.6	-0.9	0.9	6.1	6.2	4.4	-0.6	-4.4	- 7.8
		Air	11.2	8.5	6.3	1.9	0.1						3.0	10.6
Abingdon	64	Daily Min	1.0	0.9	1.9	4.1	6.6	9.8	11.6	11.3	9.6	6.8	3.8	1.9
		Extreme Min	-15.7	-18.9	-13.3	-5.5	-3.3	0.7	2.4	2.8	-1.1	-5.6	-6.7	-11.3
		Air Frost	12.5	12.0	9.3	4.0	0.2				0.1	1.1	6.5	14.3

The above values were calculated from the following periods:

daily min: Gatwick 1961-70, Manston and Abingdon 1941-70

extreme min: Gatwick 1958-75, Manston 1934-53, 61 onwards and Abingdon 1944-75

air frost: Gatwick 1963-72, Manston and Abingdon 1961-70.

The relative frequency of radiation and wind frosts for the three sites is shown in Table 3.

TABLE 3

FREQUENCY OF RADIATION AND WIND FROSTS
DURING 1 APRIL - 2 JUNE

Station	Type of Frost	Number of occasions	% Total
Gatwick (1959-78)	Radiation	121	96
	Wind	5	4
	Total	126	100
Manston (1961-78)	Radiation	23	74
	Wind	8	26
	Total	31	100
Abingdon (1959-78)	Radiation	76	84
	Wind	14	16
	Total	90	100

Discussion

The number of wind frosts at all three sites are similar, although Abingdon has an anomalously high value, and it is interesting to note that no wind frosts occurred at all during May at any station. Discussions with Mr H Pettit, S Met O, Benson, revealed that this could be associated with a channelling of cold north-easterly winds down the west side of the Chilterns, resulting in relatively high wind speeds at Benson compared with surrounding areas (funnelling through the Goring Gap also occurs during a south-easterly airstream, again resulting in relatively high wind speeds at Benson).

The percentage frequency of wind frosts at Manston is misleading because the total frequency of frosts is much lower than at Gatwick or Abingdon, due mainly to its coastal location. The proximity of the coast will have an ameliorating effect on minimum temperatures, reducing the frequency of radiation frosts while having less effect on the occurrence of wind frosts and so tending to push up the relative frequency of wind frosts. Gatwick's location, however, within a frost hollow, will have the opposite effect, tending to increase the incidence of radiation frosts thus decreasing the relative percentage of wind frosts.

Ogives of radiation frost (years in ten), were drawn for Abingdon and Manston and compared with the similar curves drawn for all frosts. It was found that the subjective smoothing of data which one has to employ when using a small sample of data (20 years) eliminates any differences between the two curves which may result from the inclusion of wind frosts in the analysis.

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References

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Cochrane J 1969 A relationship between minimum air temperatures and duration of frost in late spring. Met. Mag. Vol. 98, pp 138-140.

Any comments or suggestions on this paper should be sent to the author.

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